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Water application intensity - Calculation principles and measurement methods

Bewässerungsverfahren - Bewässerungsintensität - Berechnungsgrundlagen und Messverfahren

Techniques d'irrigation - Intensité d'apport d'eau - Principes de calcul et méthodes de mesure

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Water application intensity - Calculation principles and measurement methods

Techniques d'irrigation - Intensité d'apport d'eau - Principes de calcul et méthodes de mesure

Bewässerungsverfahren - Bewässerungsintensität - Berechnungsgrundlagen und Messverfahren

This European Standard was approved by CEN on 18 September 2003.

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Management Centre has the same status as the official versions.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
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Foreword

This document (EN 14049:2003) has been prepared by Technical Committee CEN/TC 334 “Irrigation techniques”, the secretariat of which is held by AENOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 2004, and conflicting national standards shall be withdrawn at the latest by May 2004.

According to its working program, Sub Committee CEN/TC 334 charged working group CEN/TC 334/WG 8 with drafting this standard.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This standard provides:

— principles and formulas for calculating water application intensity under sprinkler irrigation systems (fixed and moving);

— test methods and guidelines for measuring water application intensity under the different systems in laboratory and in field conditions.

It applies to stationary sprinkling systems: solid set sprinkler systems, automatic turf irrigation systems, sprinklers and sprayer for microirrigation systems, and to moving sprinkling systems: reel machine systems, centre pivot and moving laterals systems.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text, and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 12324-1:1998, *Irrigation techniques – Reel machine systems – Part 1: Size series*

EN 12324-2:1999, *Irrigation techniques – Reel machine systems – Part 2: Specifications of polyethylene tubes for reel machines*

EN 12324-3:1999, *Irrigation techniques – Reel machine systems – Part 3: Presentation of technical characteristics*

EN 12324-4:1999, *Irrigation techniques – Reel machine systems – Part 4: Check list of users' requirements*

EN 12325-3:1999, *Irrigation techniques – Centre pivots and moving lateral systems – Part 3: Terminology and classification*

EN ISO 11545, *Agricultural irrigation equipment – Centre-pivot and moving lateral irrigation machines with sprayer or sprinkler nozzles – Determination of uniformity of water distribution (ISO 11545:2001)*

ISO 7749-1, *Agricultural irrigation equipment – Rotating sprinklers – Part 1: Design and operational requirements*

ISO 7749-2, *Irrigation equipment – Rotating sprinklers – Part 2: Uniformity of distribution and test methods*

ISO 8026, *Agricultural irrigation equipment – Sprayers – General requirements and test methods*

3 Terms and definitions

For the purposes of this European Standard the terms and definitions given in EN 12324-1:1998, EN 12324-2:1999, EN 12324-3:1999, EN 12324-4:1999, EN 12325-3:1999, and the following apply.

3.1
sprinkler irrigation system
set of irrigation equipment (such as an isolated sprinkler, a set of stationary sprinklers in a solid set system, the set of sprinklers or nozzles attached to a reel machine boom, to a centre pivot system or to a moving lateral, the travelling gun attached to a reel-machine, an end-gun in centre pivot systems and moving laterals) delivering water to a surface area (i.e. to the instantaneous wetted surface)

3.2
moving Irrigation system
any kind of irrigation system moving during sprinkling. The movement can be translatory or circular, and/or continuous or intermittent

3.3
depth of water application (D)
average depth (mm) of water distributed on a surface area during a single irrigation event

3.4
instantaneous water application intensity (I)
depth of water applied per unit time during a given period of time (usually a small period of time), at a given point (usually over a small given surface area). The most common water application intensity measurement unit is (mm h^{-1})

3.5
average water application intensity (Ia)
average depth of water applied per unit time (mm h^{-1}) measured as or calculated as the average of water irrigation intensities collected : (i) over time during a time period (for example during an irrigation period), and/or (ii) over space (for example on an irrigation plot or on a part of it)

3.6
wetted surface area
surface area (S) in a plot receiving or having received water

3.7
irrigation period
irrigation period to which the water application intensity refers to can be both a unit time when the WAI (Water application intensity) is derived from hydraulic parameters or the time of watering for a local evaluation under a moving or stationary system

4 Calculation methods related to water application intensity

4.1 Depth of water application

The depth of water (D) applied is the total (the final) volume of water (Δv) delivered on a surface element (ΔS) from the beginning to the end of the irrigation period:

$$D = 1000 \frac{\Delta v}{\Delta S} \quad (1)$$

where

D depth of water application (mm);

Δv volume of water delivered to the surface area ΔS during the irrigation period (m^3);

ΔS surface area receiving water from the irrigation system (m^2).

At the system level, considering that the volume of water distributed (v) is $v = Q \times t$, the average depth of water application (D) can be expressed as:

$$D = 1000 \frac{Q \times t}{S} \quad (2)$$

where

D average depth of water application (mm);

Q flow rate passing through the irrigation system (m^3/h);

t irrigation duration of the surface area (h);

S surface area irrigated by the irrigation system (m^2).

4.2 Water application intensity (WAI)

4.2.1 General

The WAI calculation prevailing on a surface area ΔS depends on the irrigation period Δt of the application. ΔS and Δt shall be reported in results presentations.

4.2.2 Instantaneous water application intensity

The instantaneous water application intensity is evaluated using the general equation:

$$I = 1000 \frac{\Delta v}{\Delta S \times \Delta t} \quad (3)$$

where

I instantaneous water application intensity (mm/h);

Δv volume of water delivered to the surface area ΔS during the irrigation period (m^3);

ΔS surface area receiving water (m^2);

Δt duration time for which the instantaneous intensity is to be evaluated (h).

4.2.3 Average water application intensity

As sprinkler irrigation is often achieved through rotating jet(s) and/or travelling/rotating machines, the concept of "average water application intensity" is derived from equation (3) by selecting a time duration large enough to make sense with: (i) the duration of the rotation of the jet(s) of the sprinkler(s), for which the order of magnitude is typically one or a few minutes, or (ii) the duration of the travel of the irrigation machine across the plot or of the irrigation inside the plot, for which the order of magnitude is typically one or several hours.

$$Ia = \frac{D}{t} \tag{4}$$

or

$$Ia = 1000\,\frac{Q}{S} \tag{5}$$

where

Ia average water application intensity (mm/h);

Q flow rate of the irrigation system (m^3/h);

S surface area irrigated by the irrigation system (m^2);

D depth of water application applied (mm) during the irrigation period;

t time duration of the irrigation period (h).

4.2.4 Average WAI for a solid set of stationary sprinklers

Equation (6) applies to all types of fixed irrigation systems with full circle sprinkler patterns.

Using the flow rate delivered by a single sprinkler, the expression (5) of (Ia) becomes:

$$Ia = 1000\,\frac{q}{L_s \times L_l} \tag{6}$$

where

Ia average water application intensity (mm/h);

q flow rate of a single sprinkler (m^3/h);

L_s spacing between sprinklers (m);

L_l spacing between laterals (m).